tracks below. Here you don't want to have motion—you would never be able to control it. You want solidity and rigidity.

All the differences were dictated by the local geographical challenges. In the case of the Great Belt, the conditions of the sea bed demanded that the bridge be constructed at a location where it would not be standing perpendicular to the main waterway of the Belt. This meant that the ships would travel under the bridge at an angle, which is why, for safety reasons, the span of the bridge would have to be very wide, minimally 1,500 meters. The Great Belt is a major international shipping lane. A suspension bridge can have that kind of span, but it cannot carry both auto and rail traffic. A cable-stayed bridge can carry both auto and rail traffic, but it cannot have that wide a span. The solution at the Great Belt was to send the railway via tunnel and the cars via suspension bridge.

Why not use the same solution for the Fixed Link across the Øresund? Here, the shipping lanes run exactly perpendicular to the best location for a bridge. This reduced the safe width of the main span to approximately 400 meters. At the same time, it is well known that a geological fault line runs through the eastern part of the sound. An underwater tunnel in an area with many, but minute earthquakes? Not a very attractive idea. Therefore, the solution was a cable-stayed bridge for both road and rail, which could be constructed with a 400-500 meter span.

While the Øresund Bridge, for good reasons, is more sturdy in comparison with the Great Belt Bridge, the engineers took pains in their design to give the bridge some touches of grace. Each of the 41 piers that support the approach bridges, only reaches the bridge deck at two tiny points at the edges. It's like an old-fashioned waiter holding up his loaded tray with the tips of his fingers. And, by gradually changing the angles at the joints between the segments, the bridge is given a beautiful, continuous c-shaped curve along its entire length.

Since the four pylons of the high bridge carry their own part of the weight of the bridge independently of each other, there was no practical reason to put in the traditional transverse bars between each pair. But, the missing cross bars would create an annoying optical illusion. Reaching 204 meters into the skies, the laws of perspective would make the pylons look as if they were leaning towards each other when seen from the car deck. This could create panic in many family cars, if the children started screaming that the bridge was about to fall, as the car approached nearer and nearer to the pylons. Here, the engineers resorted to an old optical trick from ancient Greece. In order to make the pillars of the temples look parallel when seen from the ground, the ancient architects made them wider at the top. The same is done on the Øresund Bridge. Here, the pylons are gently leaning outwards, creating the impression—actually, the optical illusion—that they are standing perfectly parallel.

Science vs. Hype over the Human Genome

by Colin Lowry

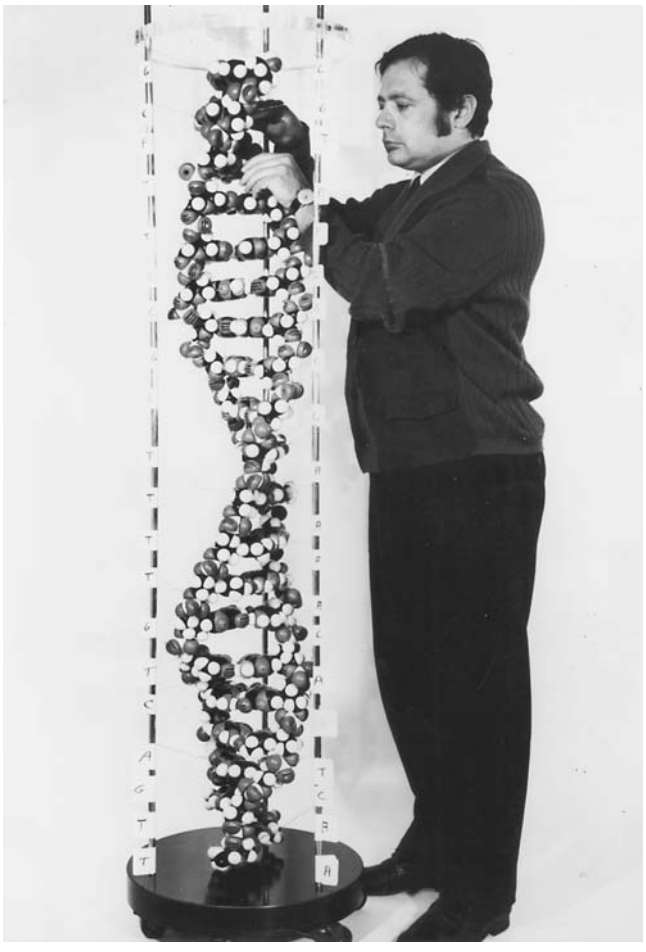
The following commentary is reprinted from the Summer 2000 issue of 21st Century Science & Technology *magazine.*

The sequencing of approximately 90% of the human genome has been hailed by President Clinton as a great breakthrough of our time, and has been compared to the discovery of a "Book of Life" by most of the popular press. Well, the President could have called a press conference a few years ago, saying we had sequenced 60% of the genome, so what has changed, why now is it a "breakthrough"?

The Human Genome Project is not a scientific breakthrough at all. Lost in all the hype, is the reality that we don't know what 97% of the DNA already sequenced means. A breakthrough in science signifies that a new principle has been discovered that changes our previous assumptions. The sequencing of the DNA of the genome has been going on for decades, yet no new principle about living systems has been learned from it alone. The identification of gene sequences that are involved in inherited diseases has been useful for early screening and treatment of people at risk, though the development of treatments has come from entirely different areas of research. The Human Genome Project is basically a brute-force application of automated DNA sequencing techniques, which have become quicker and more sophisticated over the years.

Behind the hype is a more devastating error of method, associated with the reductionist assumptions of Information Theory that dominate nearly all scientific thinking today. Just as Information Theory applied to the human mind can never describe the generation of a new thought, the sequencing of the so-called *DNA code* can never describe life. The radical reductionist view of the Human Genome Project rests on genetic determinism: Whatever happens in the cell is said to be "all in the genes."

This view turns living processes upside down, and views the cell as *existing for the sake of the DNA*. However, this approach runs into an insoluble problem in accounting for the regulation of gene activity, by creating an endless string of kinetic events of enzymes binding to DNA sequences, and DNA being transcribed into enzymes. By this logic, the cell is reduced to a complex series of chemical reactions, that in principle are no different from a machine. The Human Genome Project is dominated by this type of linear assumption, which then asserts itself onto the intrinsically nonlinear living



A DNA molecular model.

process, mentally blocking off the chance for real discoveries about what makes living processes unique.

Although it will be useful to have a two-dimensional map of the sequence of the genome, it doesn't tell us anything about the function of any of the genes. What a gene actually does can only be learned from real experiments examining the activity of the gene in a living cell.

3-D Structure, for Example

One example of how limited is the usefulness of the linear sequencing that has been accomplished, can be seen by considering the problem of three-dimensional position. The activity of a gene is controlled first by its three-dimensional structure and location within a chromosome. The familiar double-helix structure of a single DNA strand is actually wound around a myriad of proteins, and packed and reshaped at several levels of organization within a chromosome. DNA can be wound up into loops, or structures resembling an electrical solenoid. When DNA is packaged very tightly, it is in an inactive state, and cannot be transcribed by enzymes into messenger RNA, the first step toward making a protein based on the gene sequence. None of the gene's activity, or three-dimensional structure can be known from the linear sequence.

A classic example of the importance of the three-dimensional structure regulating gene activity comes from the hemoglobin gene family, which is developmentally regulated, and in human beings, the genes that code for the protein are found in the same region of the chromosome. Looking at the DNA in a linear way, scientists assumed that the regulatory region of the DNA for the hemoglobin family would be in close proximity to the gene sequences, but it was not found there.

After research revealed that the three-dimensional structure and location of the hemoglobin family was crucial to its regulation, researchers discovered that the DNA region that regulates the pattern of expression of the genes was very far away in the two-dimensional sequence, but was actually in a position three-dimensionally that exerted control over the entire structure of the hemoglobin gene region.

The Basics: What Is Life?

The sad part of the genome issue is that all of the attention and funding of the Human Genome Project, has detracted from the very research which would give us the kinds of breakthroughs that may make the DNA sequence information useful. For example, how many researchers are looking at the electromagnetic characteristics of living systems, or the potential of three-dimensional DNA structure to act as an electromagnetic transmitter and receiver? Where is the research looking for the fundamental differences between living and non-living processes? Most of it has been sidelined, while private research efforts, like that of Celera, are conducted for the purpose of "privatizing" the use of the human genome, through patents and other means. The privatization efforts have gotten so out of control that many biotech companies recently were submitting patents for fragments of human gene sequences, for which they had no clue as to their function!

It may play on Wall Street or the Nasdaq marketplace, where the much-overvalued speculative bubble thrives on such hype. But are any scientists in the field fooling themselves into thinking that this type of "speculative" research will lead to a breakthrough, which even if found, will ever be used for the benefit of the health of the public? The next time someone tries to sell you a "Book of Life," it would be wise to ask who the author is.

For clarity, we should add that we do not in any way endorse the argument that, because advanced genetic research could be used for extremely evil purposes, therefore, it should be stopped. Horror scenarios could be and are conceived in connection with nearly all areas of science — nuclear research, space, and so forth. The quickest way to make such scenarios a reality is to stop the progress of science.

Yes, the genome sequences could be useful as a first step toward medical breakthroughs, but only if other research does not suffer from the same linear, reductionist view of living systems that plagues the Human Genome Project.